

PROBLEM SET 1

Due at 5 PM on Wednesday, September 8, 2004

Here are some problems that should help to reinforce your understanding of vector and scalar electromagnetic potentials, and give you some practice working with them:

1.

Consider a uniform static magnetic field

$$\vec{B} = \hat{z} B_0 ,$$

where B_0 is a constant.

(a.)

Show that \vec{B} can arise from the vector potential

$$\vec{A}_a = -B_0 y \hat{x} .$$

(b.)

Show that \vec{B} can arise from the vector potential

$$\vec{A}_b = \frac{1}{2} B_0 s \hat{\phi}$$

(s and ϕ are cylindrical coordinates).

(c.)

By coordinate-system-independent vector analysis, show that \vec{B} can arise from the vector potential

$$\vec{A} = \frac{1}{2} \vec{B} \times \vec{r}$$

(remember that \vec{B} is constant).

(d.)

Referring to Griffiths' Eq. (10.7), find the gauge function λ that accomplishes the gauge transformation from \vec{A}_a to \vec{A}_b .

2.

Griffiths Problem 10.3.

3.

Griffiths Problem 10.5.

4.

In free space with $\rho = 0$ and $\vec{J} = 0$, show that all four Maxwell equations can be obtained correctly if the scalar potential V is assumed to vanish, while the vector potential \vec{A} satisfies

$$\begin{aligned} 0 &= \nabla \cdot \vec{A} \\ 0 &= \left(\nabla^2 - \frac{1}{c^2} \frac{\partial^2}{\partial t^2} \right) \vec{A} . \end{aligned}$$